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New geographical record and morphological features of the Indo-Pacific tropical sand goby, *Favonigobius reichei* (Bleeker, 1854) from Iranian coast of the Makran Sea (Teleostei, Gobiidae)

Reza Sadeghi,[1] Hamid Reza Esmaeili,[1,2] Ronald Fricke,[3] Helen K. Larson[4]

1 Ichthyology and Molecular Systematics Research Laboratory, Zoology Section, Department of Biology, College of Sciences, Shiraz University, Shiraz, Iran. **2** Department of Earth and Environmental Sciences, Palaeontology & Geobiology, Ludwig-Maximilians-University Munich, Richard-Wagner-Straße 10, D-80333 Munich, Germany. **3** Im Ramstal 76, 97922 Lauda-Königshofen, Germany. **4** Museum & Art Gallery of the Northern Territory, PO Box 4646, Darwin, NT 0801, Australia.

Corresponding author: Hamid Reza Esmaeili, hresmaeili@shirazu.ac.ir

Abstract

The Indo-Pacific tropical sand goby, *Favonigobius reichei* (Bleeker, 1854), is a gobiid fish native to estuarine and marine waters of the coasts of the Indian and the western Pacific Oceans. Four specimens of *F. reichei* were collected from Iranian coast of the Makran Sea during a fish survey in November 2015. The morphological features of these specimens are described and discussed. This is the first record of the species from Iranian waters and is an extension of its known range within the Indian Ocean.

Key words

Gobioidei; geographical range; range extension; morphological characteristics.

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Introduction

Gobiidae is one of the largest families of vertebrates, belonging to the perciform suborder Gobioidei, with at least 1924 species described in 309 genera (Larson and Hoese in prep); presently 1854 valid species in 5 subfamilies exist according to Eschmeyer et al. (2017). Gobiids inhabit marine, brackish, and freshwater environments in most tropical and subtropical regions of the Indo-Pacific. (Nelson et al. 2016, Froese and Pauly 2017). Members of this family live in diverse and sometimes harsh habitats, including intertidal zones, where few other fish families are well-adapted to live (Larson and Murdy 2001).

They show spectacular variety in morphology, ecology, and behavior. Despite extensive recent literature on their taxonomy, phylogeny, composition, and importance in coastal water biodiversity, their phylogenetic relationships with many groups of gobioids are not yet stabilized, perhaps due to their small size and lack of immediate economic importance. (Nelson et al. 2016, Agorreta et al. 2013). Gobies are generally benthic and occupy a wide range of habitats, from rivers and mangrove mudflats to coral reefs. They attain a small body size (often less than 50 mm). They are distinct with pelvic fins usually wholly or partially joined into a disc and have separate spinous and rayed dorsal fins (Thacker 2012).

Gobiid fishes have been sometimes misidentified in studies conducted in the Persian Gulf and Gulf of

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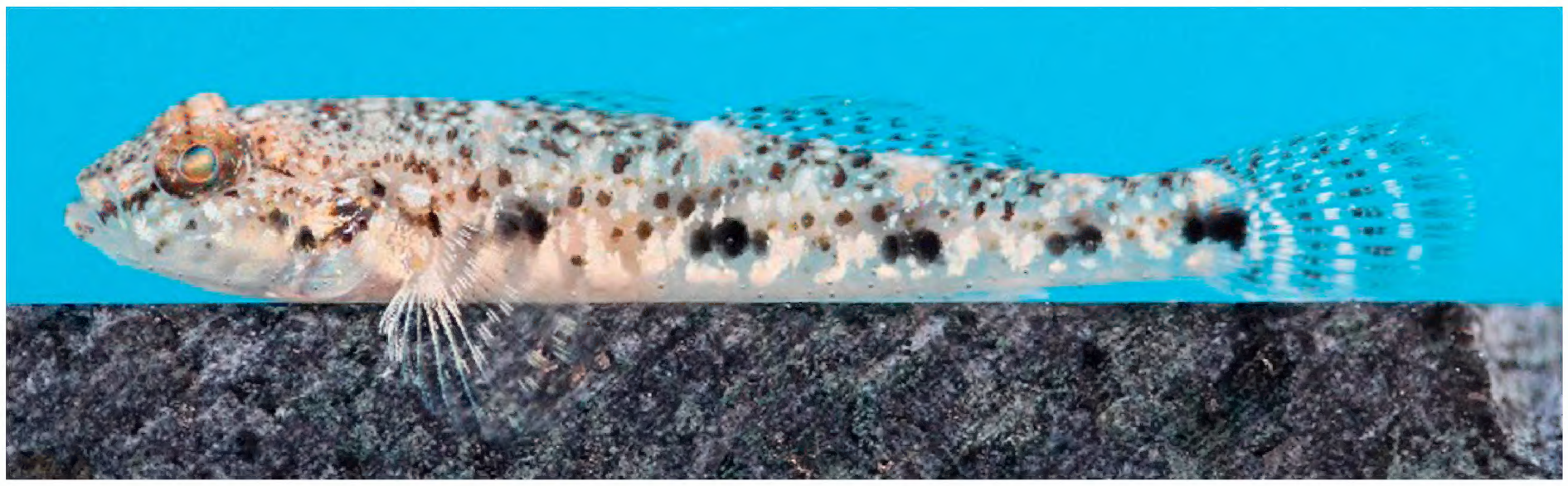

Figure 1. *Favonigobius reichei*, 29.45 mm SL collected from coastal area of Gatan village, Makran Sea, Iran.

Oman, probably due to their small size and lack of current literature. One of the earliest studies on the fishes of Iranian waters of the Persian Gulf is that of Blegvad and Loppenthin (1944), in which they reported 12 species of gobiids. Later, Kuronuma and Abe (1972) reported 4 species of this family from the coastal waters of Kuwait. In a field guide to the marine fishes of Kuwaiti waters (Jones 1986), 6 species of Gobiidae were listed from the area, while in Carpenter et al. (1997a), the number of gobiid species was increased to 44, of which only 14 species were accompanied by schematic figures. Furthermore, Carpenter et al. (1997b) reported 15 species of Gobiidae from the coral reefs of Kuwait. Bishop (2003) reported 26 gobiid species from the southern Persian Gulf and Rahimian and Pehpuri (2006) reported 8 gobiid species from Qeshm Island.

The genus *Favonigobius* Whitley, 1930 commonly referred to as a "sand goby" currently comprises 9 valid species (Froese and Pauly 2017). According to Larson and Murdy (2001), the genus *Favonigobius* can be diagnosed by the presence of a large patch of papillae on chin; multiple short irregular rows of papillae on cheek between 2 lowermost longitudinal papillae rows and papillae row directly under eye double; 5 to 6 longitudinal rows of papillae on cheek; first or second dorsal-fin spine may be elongate in mature males; snout short and pointed; no scales on cheek or opercle; whitish to pale yellowish body with fine dark spots and speckles; and dark spots along midside of body smaller than eye.

Favonigobius reichei Bleeker, 1854, commonly referred to as the Indo-Pacific tropical sand goby, is known so far from South Africa west to Ponape (Micronesia) and north to Japan; it has a wide distribution in the Red Sea, Indo-West Pacific, East Africa, South Africa, Seychelles and Mauritius (Mascarenes) east to Marshall Islands and New Guinea, north to southern Japan, and south to northern Australia and New Caledonia. (Larson in press, Kottelat et al. 1993, Fricke 1999, Patzner et al. 2012).

Although *F. reichei* has been reported from coastal areas of Oman (Al-Jufaili et al. 2010), there has been no record of it from the Iranian coast of the Makran Sea (Rahimian and Pehpuri 2006, Ghanbarifardi and Malek 2007). Hence, the main objective of this work is recording *F. reichei* for the first time from the Iranian coast of the Makran Sea and providing its morphological characteristics.

Methods

Four specimens of *F. reichei* with total lengths (TL) of 29.5–34.7 mm and standard lengths (SL) of 23.3–29.5 mm (Fig. 1) were collected from a shallow rocky reef interspersed with sandy coastline of Gatan village, between Sirik and Jask ports, Hormozgan province, Iran, 25°57′ N, 057°15′ E, 6 December 2015, using a hand net (Figs 2–4).

Due to the small sample size and detailed examination for example molecular analysis, after anesthesia, the specimens were fixed in 95% alcohol and brought to the laboratory. The specimens are deposited in the Zoological Museum of Shiraz University, Collection of Biology Department, Shiraz (ZM-CBSU) under museum numbers of ZM-CBSU M1579, ZM-CBSU M1580, ZM-CBSU M1594, and ZM-CBSU M1595.

Morphometric measurements were taken to the nearest 0.1 mm using digital calipers. A stereomicroscope was used for the meristic characters. Morphometric characters were expressed as % standard length (SL) and % head length (HL). Morphometric methods followed Miller (1988); meristic methods followed Chen and Fang (2006) and Chen and Miller (2008). Meristic abbrevia-

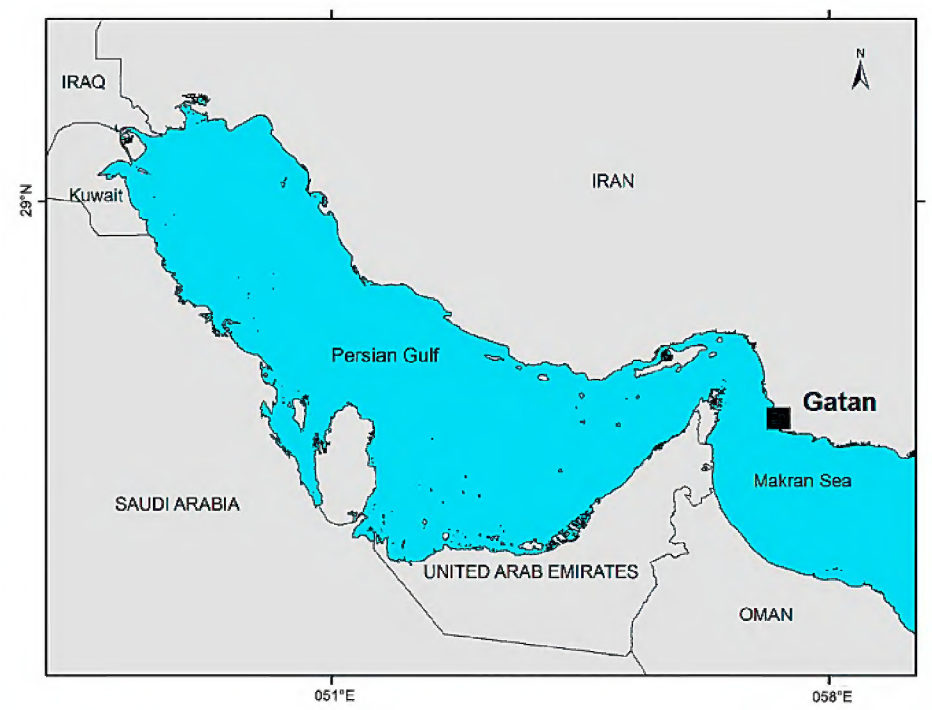

Figure 2. Collection site of *F. reichei* from coastal area of the Makran Sea, Iran (25°57′ N, 057°15′ E).

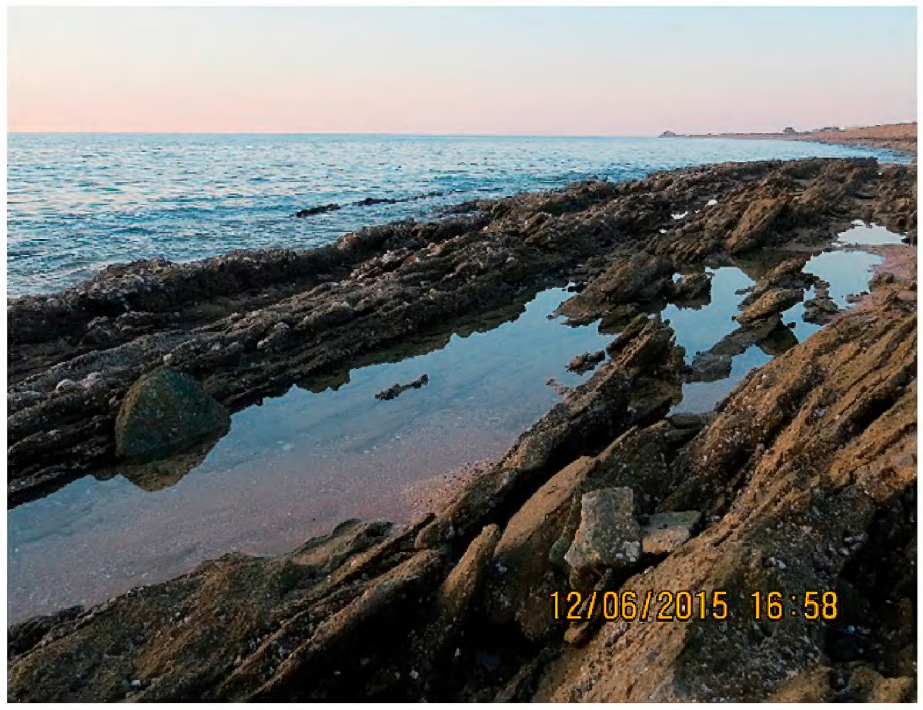

Figure 3. Gatan shore, Hormuzgan Province, Iran; new collection site for *F. reichei*.

tions are as follows: D1 = First dorsal fin; D2 = Second dorsal fin; V = Ventral fin; A = Anal fin; P = Pectoral fin; PSD = Predorsal scales; LSS= Longitudinal scales series; and TSS = Transverse scales series. Morphometric measurements were made to the nearest 0.1 mm using caliper.

Results

We primarily used the key of Larson and Murdy (2001) for the identification of the genus of *Favonigobius* and subsequently identified the collected individuals as *F. reichei* by analyzing the following morphometric and meristic characters:

Fin ray counts D1: VI; D2: I, 8; A: I, 8; P: *15; PSD: 2; LSS:* 29; TSS: 8.

See Figure 1 for general appearance; morphometric data are given in Table 1. Body moderately elongate; head short (27–29 % SL); snout short, steep and pointed; eyes dorso-lateral and not large; interorbital space less than one-eighth eye diameter; anterior nostril tubular, without tentacles, posterior nostril pore-like, near orbit; mouth oblique; jaws equal, posterior angle of lower jaw between anterior edge of orbit and pupil; chin without barbels or transverse fold; teeth in jaws erect and caniniform, in several rows medially, outer row of teeth in both jaws enlarged; pharyngeal teeth caniniform; tongue truncate; caudal fin rounded, usually slightly longer than head; pectoral fins without free rays; pelvic disc complete (united medially), pelvic frenum present and well developed; *preopercle without spines*; gill rakers 1 +8, and simple on first arch, spinulose on internal and external side of rest in groups 2–4; pre-pelvic scales large and cycloid; belly scales small and cycloid; head, opercle and cheek naked; scales ctenoid except cycloid on breast and pectoral fin base; scale absent on remainder of head; multiple longitudinal head papillae pattern; and single anterior interorbital pore (Fig. 1).

Table 1. Morphometric characters of 4 specimens of *F. reichei* collected from the Coast of Makran Sea. All values except for total length (TL) and standard length (SL) are proportions.

Morphometric measurements	Min.	Max.	Mean
Total length (TL, mm)	29.48	34.68	31.16
Standard length (SL, mm)	23.30	29.45	25.36
Standard length (SL) /Tl	0.78	0.85	0.81
Head length (HL) /Sl	0.27	0.29	0.28
Body depth at pelvic origin (BDP) /Sl	0.14	0.16	0.15
Head width (HW) /Sl	0.17	0.21	0.19
Pre first dorsal length (Pre-FDL) /Sl	0.33	0.37	0.36
First dorsal fin base length (FDFL) /Sl	0.06	0.09	0.07
Second dorsal fin base length (SDFL) /Sl	0.14	0.22	0.18
First dorsal fin length /Sl	0.16	0.18	0.17
Second dorsal fin length /Sl	0.27	0.36	0.30
Pectoral fin length (PcFL) /Sl	0.20	0.27	0.23
Pelvic fin base depth /Sl	0.07	0.11	0.09
Pre pelvic length /Sl	0.30	0.37	0.32
Anal fin base length (AFL) /Sl	0.17	0.20	0.18
Anal fin length /Sl	0.26	0.30	0.28
Pre anal fin length (PAL) /Sl	0.54	0.58	0.56
Caudal peduncle length (CPL) /Sl	0.21	0.26	0.23

According to genital papilla, all 4 specimens are female. Head and body are whitish to pale yellowish, the upper two-third of body with numerous small brown and black spots and blotches on scales; a mid-lateral row of blackish spots with 4 or 5 slightly enlarged groups of black spots, the first beneath pectoral fin, last spot on caudal peduncle often paired without a vertical bar at caudal base; median fins spotted; paired fins pale; and a short black and oblique streak on side of snout extending from antero-ventral edge of eye to across lips. Basal two-thirds of D1 and D2 and caudal fins with small black spots on a white reticulum (Fig. 1).

Favonigobius reichei is very similar in appearance to *F. melanobranchus* (Fowler, 1934) (Fig. 5). However, *F. reichei* is distinguished from *F. melanobranchus* by having 8 or 9 transverse scales rows (vs 7 transverse scales rows) and 1 or 2 predorsal scales (vs 7 predorsal scales in *F. melanobranchus*). Moreover, *F. melanobranchus* has black spots on the upper edge of the caudal fin and its membranes at sides of isthmus are black (Fig. 5).

Based on Bogorodsky et al. (2011), the principal colour characters distinguishing these species are the presence of a black spot or oval blotch dorsally on the caudal fin of *P. melanobranchus* (absent in *P. reichei*), and the presence of orange lines on lower part of body of *P. melanobranchus* (absence *in P. reichei*, though may be indistinct). Underwater photographs of *P. reichei* for comparison may be seen in Senou et al. (2004) and Larson and Lim (2005).

Key to *Favonigobius* species of the study area

a Predorsal scales in 7 rows, but scales not reaching eye; males with black spot dorsally on caudal fin and often with black on branchiostegal membranes ..... *F. melanobranchus*

b Predorsal with 1 or 2 scales; males without black spot on upper part of caudal fin and branchiostegal membranes always pale ..... *F. reichei*

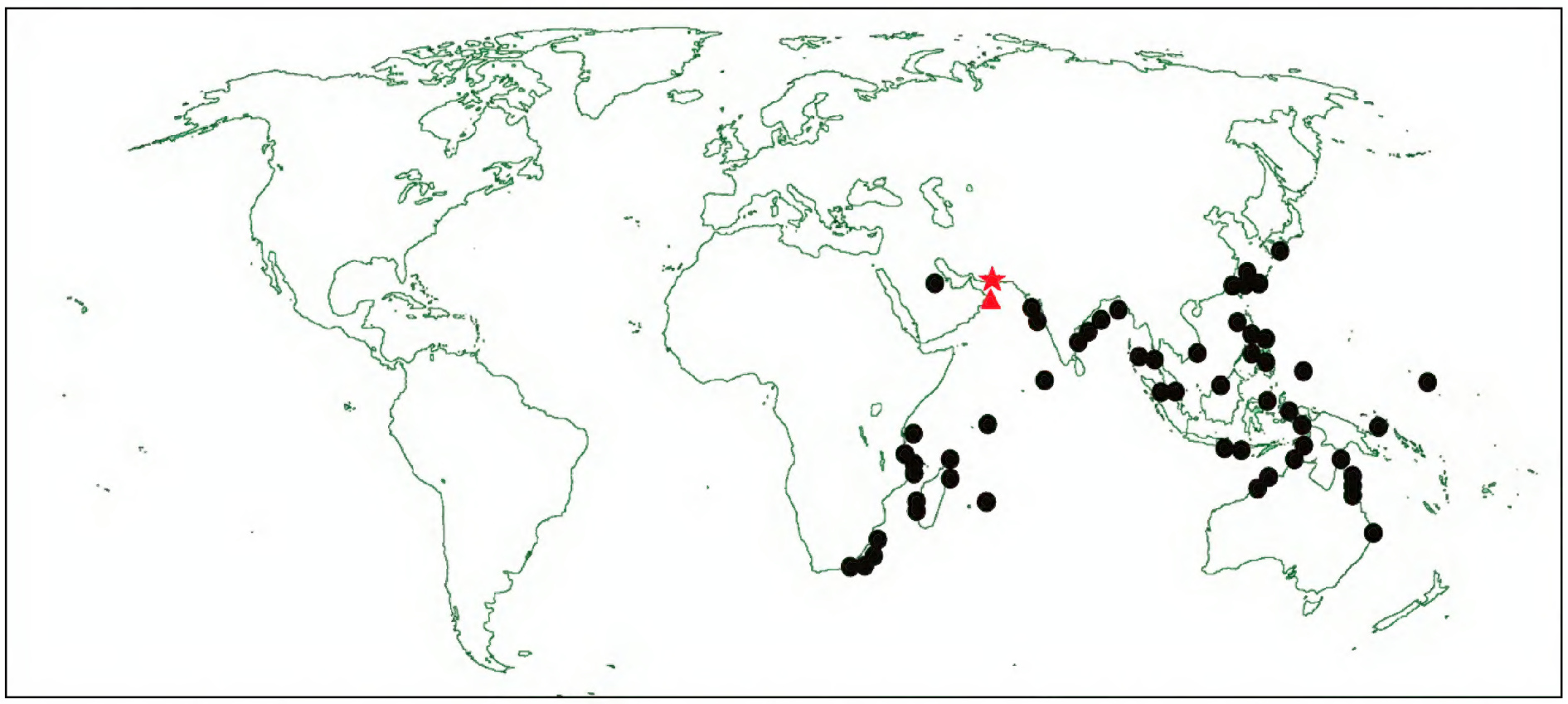

Figure 4. World distribution map of *F. reichei*, including new record (red star) and previous record from Oman coastal area (red triangle).

Figure 5. *Favonigobius melanobranchus* (Fowler, 1934), freshly collected specimen, PMR 2218**,** male, 45.5 mm SL, Gulf of Suez (Photo S.V. Bogorodsky), (with permission of Bogorodsky, S.V., Kovačić, M. and J.E. Randall).

Discussion

Favonigobius reichei is a euryhaline fish and has a wide distribution (Fig. 4) in the Red Sea, Persian Gulf, Gulf of Oman, Mozambique, South Africa, Seychelles and Mauritius (Mascarenes) east to New Guinea, north to southern Japan, and south to northeastern Australia (Larson in press, Masuda et al. 1984, Kottelat et al. 1993, Fricke 1999, Patzner et al. 2012). It is found at depths of 0–5 m. This species is found over muddy or sandy bottoms, often in weedy areas of the intertidal zone, and also in mangroves, estuaries, lagoons, and downstream parts of rivers.

Favonigobius reichei is a common Indo-Pacific tropical sand goby inhabiting rocky to sandy bottoms, with at least 143 georeferenced records worldwide in Global Biodiversity Information Facility (GBIF 2017).

The present record is a new addition to the marine fish species list for Iran. The discovery of *F. reichei* in Iranian waters indicates that a suitable habitat for this species occurs along the Iranian coast of the Makran Sea and that additional species of sand goby in the subfamily Gobiinae may be discovered in the future.

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Authors' Contributions

RS collected the specimens; RS and HRE examined and identified the specimens; and RF and HKL verified the specimens. RS and HRE prepared the figures. All authors prepared, reviewed, finalized, and approved the manuscript.

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